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The Impact of Aesthetic Preference in Product Design–Golden Ratio and Korean's Preference Proportion

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Abstract

Background Over the past decades a considerable number of studies have been done on the golden ratio and the relation between their aesthetics and design. These studies, after analyzing design icons with the golden ratio, seem to prove that the golden ratio is an important principle for good design. However, these studies mainly focused on western products that were used in western countries. And thus, the majority of the products were designed by western designers and analyzed by western scholars. These factors raised a doubt whether the golden ratio is also the most aesthetically pleasing proportion in other countries, for example in Asia. Proportions are determined by mathematical logic; however preference and aesthetic judgment are aroused from individual's experience and environmental context. Questioning whether the golden ratio is the most commonly preferred proportion across cultures led to an empirical study to examine the differences between Western and Asian preferences on the golden ratio. Specifically, this study is focused on Koreans' preference and their traditional products.

Methods First, the preference experiment on proportion was conducted in South Korea with 277 subjects. Second, this study continued to analyze the proportion of over 100 Korean traditional objects that exemplify the research results.

Results The experimental data clearly reveals that Korean subjects have a significant preference for the root ratio (1:1.414). This result obviously contradicts previous studies conducted in western countries that showed a strong preference for the golden ratio, and their good design objects are also characterized by the golden ratio (1:1.618). This study continues to verify that Koreans' favorite ratio could be found in Korean traditional design objects reflecting their preference. Korean traditional design objects show a clearly shorter ratio (1:1, 1:1.333) than the golden ratio (1:1.618).

Conclusions It is concluded that the golden ratio is not always the best proportion for a good design, but it may be a preferred proportion since this ratio can be found in everyday objects as one of the predominant design features. Specifically, this finding will evoke deeper insights in the correlation of an influential impact between aesthetic preference and the element of design form and shape.

Keywords Experimental Aesthetics, Visual Preference, Cultural Differences

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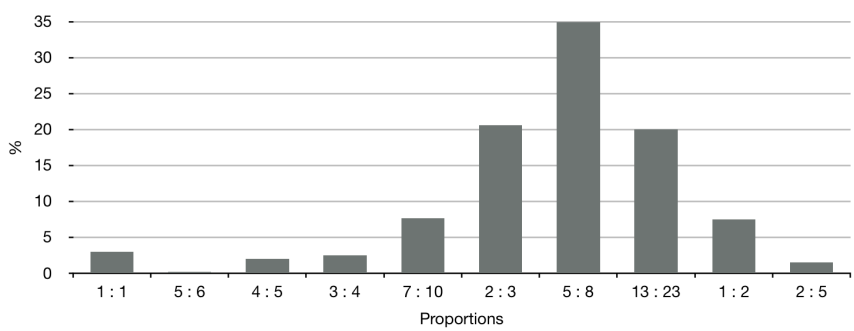
1. Introduction

Over the past decades a considerable number of studies have been proved that the most beautiful proportion is the Golden ratio (Green, 1995; Jung & Munn, 2007). The Golden ratio and or golden section are undoubtedly one of the most known and widely used proportion and most famous ratio (Elam, 2001). The Golden ratio is a geometric proportion system based on the equation of two ratios: a/b = b/a + b = 1.618 (Berlyne, 1970). It is also a constant ratio that is 'irrational' in numeral terms as for example as a numerical quantity, i.e. ø = 1.618, or ø = (√5 + 1)/2 (Wallschlaeger, Busic-Snyder, & Morgan, 1992). This golden ratio is mostly remembered through the Greeks that used this system to achieving beauty and visual order, which has been emulated through the western ages from da Vinci, Durer and Corbusier to today (Posamentier & Lehmann, 2011). Proportion is an essential design principle, especially the golden ratio is one of the crucial 'good design' elements that organize design and human perception (Hoge, 1997). Gustav Theodor Fechner (1801 – 1887), an early pioneer in experimental psychology and founder of psychophysics(Fancher, 1996), presented various empirical studies to confirm the aesthetic value of the golden ratio, and he concluded the golden ratio is more aesthetically pleasing than any other proportions of rectangles (Fechner, 1876). In Fechner's experiment, ten different sizes of rectangles were shown to participants and they were asked which one they prefer the most. Fechner continued his research findings on objects, which had rectangular shapes in particular and found that the average proportion was always close to the golden ration (1:1.618) (Fechner, 1871). Moreover, people's preference steered towards objects that kept those proportions. Its aesthetic preference also can be found in great works of art, design artifacts and historical architecture from ancient times till the present (Green, 1995).



Ratio	1 : 1	5 : 6	4 : 5	3 : 4	7 : 10	2 : 3	5 : 8	13 : 23	1 : 2	2 : 5	Total
■ Fechner 1876	3	0.2	2	2.5	7.7	20.6	35	20	7.5	1.5	100%

Figure 1 Percentages of most preferred proportions on Fechner's experiment

This figure shows the results of Fechner's experiment on the most preferred proportions. The x-axis indicates the ten different rectangle proportions from 1:1 to 1:2.5 that were presented to the subjects, and the y-axis shows the percentage of preference. In Fechner's experiment, the golden ratio (5:8) was preferred the most with 35% and the ratio 2:5 the least with 1.5% (Fechner,1871). Lalo (1908) repeated Fechner's experiments and indicated the same results as other researchers after him. This empirical experiment continued until the present, and

the results were close to the Golden ratio (Weber, 1931; Thompson, 1946; Nienstedt&Ross, 1951; Eysenck & Tunstall, 1968; Godkewitsch, 1974; Piehl, 1978; McManus, 1980). Also in modern products the golden ratio still plays an important role. For example, looking at automobiles, the Volkswagen Beetle analyzed by Kimberly Elam (2001), the car once shown to people that was most liked in the Western society; fits perfectly to the ellipse of the golden ratio. Proportion also can be analyzed in furniture design, closets from the Baroque and Renaissance period (Jung, Zahn, Badke-Schaub & Munn, 2011). In architecture, the Parthenon temple in Greece, the facade of the Parthenon is embraced by a subdivided golden rectangle and the height of the architrave, frieze, and pediment (Akhtaruzzaman & Shafie, 2011). Fechner's interest in aesthetics aroused an idea that typical aesthetic preferences between cultures might exist, since the previous studies mainly focused on western products that were widely implicated in western countries, no similar experiments were performed in Asian countries. And of course, the majority of the products are designed and analyzed by western designers and scholars (Fancher, 1996). Hence, the same experiment of Fechner was conducted in South Korea with 277 participants in 2006 and 2012, and compared to the proportions of their cultural heritages and design artifacts. Although Asian products are overflowing, but it is less recognized what philosophy and shapes an Asian product does have. These facts are raised a doubt whether the golden ratio is also the most aesthetically pleasing proportion in other Asia countries, for example in South Korea. Our findings arouse attentions that there might be a statistically significant difference between Western and Asian subjects on the aesthetic preferences of proportion. Aesthetics has particular relevance to human behavior: aesthetics is innately appreciated (Langlois, Ritter, Roggman, & Vaughn, 1991), as evolutionary benefits (Dutton, 2003), and is applicable in a product context. Research on human perception and aesthetics implies the preference for beauty is from intrinsic factors (Townsend & Sood, 2012). Especially, proportion is a fundamental component of design with impact on the human's cognitive and emotional 'setting' seems to be a large contributor on our emotional influence (Desmet, 2002). In this perspective, this study has a great need of knowledge in understanding South Korean's aesthetic preference and the correlation with their design objects; especially this study focused on proportions, as it is one of the most important design elements.

2. Method

2. 1. Participants

A total of 277 subjects were tested. Their mean age was 23 years ranged from 20 – 30 years, and there were similar numbers of gender with 135 male and 142 female. Most participants were research volunteers who were selected randomly from Korea University in Seoul and Koreatech in Cheonan. The task was assigned individually, and at the end of the experiment; participants completed a questionnaire and provided demographic information. TU Delft and Koreatech approved the experimental protocol and all participants gave informed consent.

2. 2. Design and Procedure

Study 1. The subject informed in a simple way that they were taking part in an aesthetic experiment without the explanation of the preceding research background. Intentionally, the subjects were asked to do the task verbally one by one without a written instruction and they were presented with a set of ten different proportions of rectangles only. They were able to interact with the shapes that had no particular order for a few minutes, and asked to choose which ratio they feel the most comfortable with. The instructions referred to adjectives "feels good", "like the most", "more attractive" rather than nouns "beautiful", "aesthetics". This was done purposely to control for the possibility that the stereotypes of beauty in the word might affects people's preference. Although there was no time limitation, some participants momentarily hesitated to choose the most preferred one with their second preferred rectangle, but they completed the task quickly in 2-3 min.

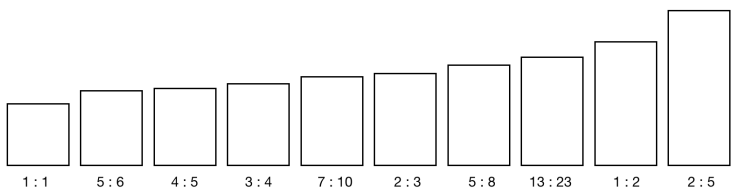


Figure 2 Ten different proportions for Fechner experiment

A set of rectangles made by a white paper form board, ten different proportions with a thickness of 5mm. The smallest rectangle was a square with 8 cm side. All other rectangles had short sides of 8 cm and the longer side increased to a maximum 20 cm at regular intervals by ten different ratios, 1:1, 5:6, 4:5, 3:4, 7:10, 2:3, 5:8, 13:23, 1:2, 2:5 (Figure 2). After the task, participants received a questionnaire and wrote down their choice by themselves. The questionnaire had two parts. The first part was a choice question composed of ten choices from A (1:1) to J (2:5) in alphabetical order. The second part was made up to ask the subjects on "personal specifications", subjects were filled in a questionnaire that asked basic demographics, gender, age, height, and nationality. These specifications were particular considered due to the potential influence factors with the preferences of proportions. The first part was hidden from the second part to decrease the influence to the subjects.

Study 2. The second study focuses on the analysis of Korean traditional objects (N=100) and its proportions (Appendix1). Products were selected from the start of the 17th until the start of 20th century, and were chosen through the collection of National Museum of Korea and National Folk Museum of Korea (Pangmulgwan & Séoul, 2007). The product analysis is important, since it represents the visual thinking process that "pervades all human activity, from the abstract and theoretical to the down-to-earth and everyday" (McKim, 1972). Thinking and visualizing is obvious when seen in the context of architecture, design or the visual arts, however visual analysis seem not to appear to be a part of science and technology, but it could not be further from the truth (McKim, 1980). Consequently, visual thinking is an important factor to progress design, it is the observation of what is seen that is applied by the designer so methodological (McKim, 1972). The importance of context and product analysis is an essential part of this chapter, since objects are not only analyzed for its sake of their existence, but for the iconic or contextual origins. The product selection for this analysis

was based on historical context, but also for their representation of timelessness – classical design. The main category that analyzed was national treasures that used in ordinary daily life in Korea. These products are presented in chronological order with the relationship to proportions and design of the time between the 17th and the early 20th century. This second study tries to explain the visual principles of wide selection of products that are analyzed by the geometric compositions. The products that were selected for analysis are considered as classical design from the various uses of traditional household goods in Korea. The proportion analysis of Korean objects shows root proportion (1:1.414) that are inscribed in a root 2 rectangle construction diagram: traditional furniture from the Joseon Dynasty (1413 - 1865), electronics, automobiles, and ancient Korean grain storage clearly shows root proportions (Jung et al., 2011). These proportions differ from previous products analysis, Baroque and Renaissance surfaces, which clearly showed the Golden ratio (Posamentier & Lehmann, 2011). Similar analyses were done with modern Korean products. Stated by a Korean design research group, the Ssangyong New-Korando exemplifies as a typical Korean car design, and it is clearly shows root rectangle. The Kim-chi refrigerator is specific to Korean culture needs. The refrigerator aligned its surface on a root rectangle (1:1.414) (Jung et al., 2011). Geometrical proportions in architecture can be widely observed through regulation lines that dictate the placement of doors, windows and their proportions to the facade. The layouts of ancient Korean residential houses analyzed and observed to be laid out on root proportions. These houses were from the Mumum pottery period that is known for the origin of intensive agriculture and complex societies in Korea (Bale & Ko,2006). The analysis tools are based on the previous proportions studies. Specifically, the tool that used to analyze Korean objects was based on the root 2-rectangle construction method described by Elam in her book “Geometry of Design: studies in proportion and composition”, noting that the diagrams were selected from the “The Geometry of Art and Life” (Ghyka, 1977). To have a better understanding of the product analysis, the analysis method has to be explained in detail. The proportion of products was calculated by the actual size of each products with their height, width, and depth.

Figure 3 Square table with dog legs (19C) by National Folk Museum of Korea (Left) and proportion analysis (right)

For example, the proportion of a square table with dog legs with the size of 33.4(d) x 33.4(w) x 21.0(h)(cm) was analyzed by its depth and width, so its proportion is close to 1: 1 (Figure3). Because, the top side (depth and width) of the table is more relevant than the front side (width and height) with the usage of the table. In case of a cabinet, the front view is more appropriate than its top side as a cabinet is used from the front view. In this perspective, the analysis method of a product proportion was organized by the usage of each product, so 100 objects were analyzed by this criterion.

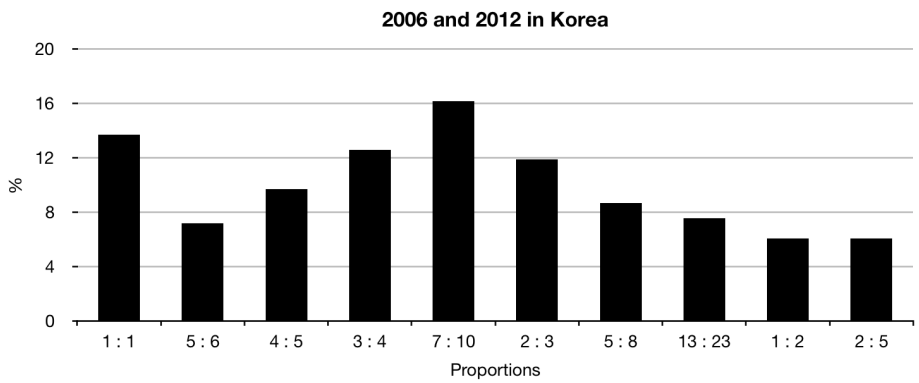
2. 3. Data Analysis

The data of Study 1 was collected as a follow-up experiment in 2007 and 2012 each, the first experiment was carried out from September 2006 to January 2007, and the second experiment was carried out from November 2011 to February 2012. Although there was a 5-year gap, the result was minor differences between two separate experiments; therefore, the data was combined for this study. The two experiments used the same stimuli, conditions, and questionnaire, and statistical analysis was carried out using SPSS 23.0. Study 2, product analysis, was conducted in 2017.

3. Result

3. 1. Study 1 Experiment on proportion preference

In study 1, to test the hypothesis, Asian subjects will prefer a different rectangle proportion compare to Western subjects, this study used Fechner (1876) experiment method. Participants were asked to choose which of the rectangle proportion is the most aesthetically pleasing. The results show that Korean prefer the 7:10 rectangle the most (Figure 4) in contrast with the result of Fechner's experiment that significantly preferred the 5:8, the Golden ratio the most (Figure 1).



Ratio	1 : 1	5 : 6	4 : 5	3 : 4	7 : 10	2 : 3	5 : 8	13 : 23	1 : 2	2 : 5	Total
Participants	38	20	27	35	45	33	24	21	17	17	277
%	13.7	7.2	9.7	12.6	16.2	11.9	8.7	7.6	6.1	6.1	100%

Figure 4 Most preferred proportions in Korea (2006 & 2012)

The graph demonstrates on the x-axis ten different rectangle proportions and on the y-axis the percentage of preference. The result revealed that 16.2 % with 45 subjects preferred the root ratio of 7:10. The second preferred ratio was a perfect square (1:1) with a preference of 13.7% with 38 subjects, which is also significantly high percentage compared with the most preferred proportions 7:10 (16.2 %).

Table 1 Results of Chi-Square goodness of fit test for Korean participants

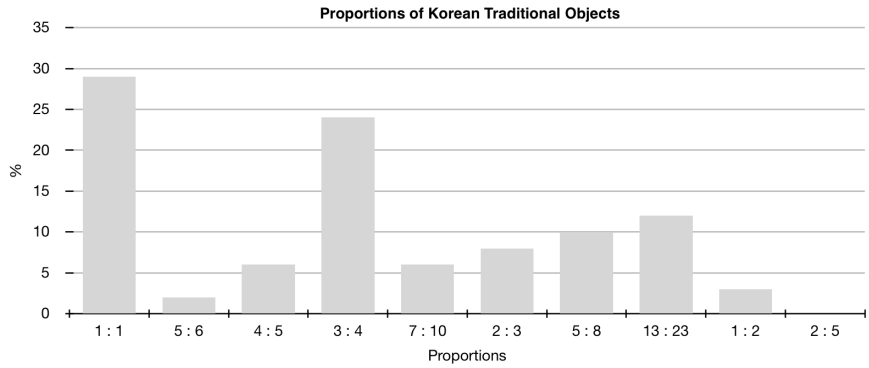
Test statistics				
Variable		Korea (n=277)	χ^2 (9)	p
Proportions	1 : 1	38	112.7	.000
	5 : 6	20		
	4 : 5	27		
	3 : 4	35		
	7 : 10	45		
	2 : 3	33		
	5 : 8	24		
	13 : 23	21		
	1 : 2	17		
	2 : 5	17		

Table 1 presents a statistically significant: χ^2 (9) = 112.7, $p < 0.001$, therefore, it supports the differences that Korean's the most preferred proportion is 7:10 (N = 45) compared to either the 1:1 (N = 38) or 3:4 (N = 35) proportion. Overall, Korean subjects prefer shorter ratios than Fechner's subjects in Germany. The exploration of this specific preferred proportion represented in the experiment inspires a curiosity whether this implicit result of aesthetic judgment is represented in our daily life as physical reality. Reality can be observed through nature and the creations of human, thus it is important to see the relationship between the metaphysical and the physical perceived through proportions. This was the stimulus of Gustav Fechner's own thought process as he measured "commonly seen rectangles – playing cards, windows, writing paper pads, book covers – and found that the average was close to the golden rectangle" (Huntley, 2012). In following Gustav Fechner's ideals protrude a hypothesis in two major roots in the creations – the golden ratio with western products and the root ratio within East Asian from the object analysis.

3. 2. Study 2 The analysis of Korean traditional object proportions

The purpose of the product analysis has two parts; the first part is to establish significant relationship between the preferences of proportions, the second part is to establish a better knowledge on Asian design identity, especially focused on the proportions of Korean products for this study. The previous pilot analysis (2.2) encouraged a larger analysis over a longer period considering the possibility of patterns that has been shown in product proportions. Hence, 100 objects were analyzed including the 3 categories by the area: living room, kitchen, and bedroom ranges, for example, brush rest, inkstone case, bamboo plated inkstone table, inkstone table, filing trays, a book storage, wooden pillow, a checker board, handcrafted mother of pearl box, and etc.

Specifically, these products were selected for analysis that stood the test of time and in many respects can be considered as design classics in South Korea. This analysis provides a deeper insights why certain objects were formed in a certain proportion, moreover highlights the importance of the objects existence that shaped design and history, creates the objects iconic.



Ratio	1 : 1	5 : 6	4 : 5	3 : 4	7 : 10	2 : 3	5 : 8	13 : 23	1 : 2	2 : 5	Total
N	29	2	6	24	6	8	10	12	3	0	100
%	29	2	6	24	6	8	10	12	3	0	100%

Figure 5 Percentages of proportions of Korean traditional objects

Figure 5 shows Korean traditional objects that were analyzed by the proportions. The result shows the majorities 29 percent of objects were closed to a perfect square (1:1), and 24 percent of objects are placed at the proportion of 3:4. Interestingly, the most preferred proportion for Korean, the root ratio was revealed in their objects with only 6 %. Nevertheless, it still provides a valuable enlightenment that Korean objects has a shorter ratio than western products do have. To conclude, the result shows that the most preferred proportion for Korean traditional products is 1:1. It is interesting to see the root ratio (7:10) is quite low percentage for the object analysis, but it still coincides with the result from the proportion experiment that showed a strong preference for 1:1 and 3:4 with each 13.7% and 12.6% (Figure 4).

4. Conclusion

A proportion is determined by mathematical logic, but preferring a proportion is steered by learning and experience, affected by not only physical needs but also internal satisfaction concerning the proportion of design principles. Furthermore, there are differences on proportions analyzed on products, and these proportions are preferred by their particular culture the most. An empirical investigation, which was a repetition of Fechner's experiment, has been done to explore any possible differences between the East and the West. For this reason, this study is concerned with the relationship between proportions and product design and its cultural background, specifically the principle of formative arts, the Golden ratio. Summarizing, it could be stated that based on the empirical data analyses of Korean preferences and products, Korean people prefer a shorter ratio than the Golden ratio. This result has two implications:

1. Korean subject prefers shorter proportions than Western subject.
2. The Golden ratio is not a general preference of all human beings, but seems to be culturally influenced.

To conclude, the result of this study leads to the necessity to assess and define 'preferred proportion' anew. The golden ratio is not always the best proportion for a good design, but the preferred proportion might be the answer as it is reflected in daily life objects as one of the predominant design features. This knowledge could be easily used to explore new design strategies that are useful in retail, automobile or even design education.

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